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For: APPARATUS AND METHOD FOR AUTOMATICALLY ADJUSTING TILTING OF AN OPTICAL DISC DRIVE

SUBMISSION OF ENGLISH TRANSLATION

Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

Sir:

Attached is the English translation of Korean Patent Application No. 10-2002-0057810, filed in the U.S. Patent and Trademark Office on July 16, 2003. It is respectfully requested that the attached English translation be made of record in the above-identified application.

If any further fees are required in connection with the filing of this English Translation, please charge same to our Deposit Account No. 19-3935.

Respectfully submitted,

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CERTIFICATION OF TRANSLATION

I, ***Soog Jin Lee***, an employee of Y.P.LEE, MOCK & PARTNERS of Koryo Bldg., 1575-1 Seocho-dong, Seocho-gu, Seoul, Republic of Korea, hereby declare under penalty of perjury that I understand the Korean language and the English language; that I am fully capable of translating from Korean to English and vice versa; and that, to the best of my knowledge and belief, the statement in the English language in the attached translation of ***Korean Patent Application No. 10-2002-0057810*** consisting of ***24*** pages, have the same meanings as the statements in the Korean language in the original document, a copy of which I have examined.

Signed this 24th day of March 2006

Soog Jin
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ABSTRACT

[Abstract of the Disclosure]

Provided is an apparatus for automatically adjusting tilting between an optical pickup unit sliding along a pair of rails supported by three adjusting parts and one fixing part and a turntable on which an optical disc drive is placed. The apparatus includes placing parts, a plurality of height measurers, adjusters, a mirror disc, two mirror plates, an autocollimator, a photo detector, and a controller. The optical disc drive is placed placing parts. The plurality of height measurers measure heights of two portions of each of the pair of rails. The adjusters raise the adjusting parts. The mirror disc is mounted on the turntable and spins. The two mirror plates are installed close to the turntable across the pair of rails. The autocollimator radiates parallel light beams onto the mirror disc and the two mirror plates. The photo detector detects focused points of the light beams reflected from the mirror disc and the two mirror plates and passing through the autocollimator. The controller calculates an amount of tilting from a distance between the focused points. Since a process of adjusting tilting can be automatized, an efficiency of a process of manufacturing optical disc drives can be improved and cost for manufacturing the optical disc drives can be saved

[Representative Drawing]

FIG. 2

SPECIFICATION

[Title of the Invention]

Apparatus and method for automatically adjusting tilting of optical disc drive

[Brief Description of the Drawings]

FIG. 1 is a perspective view of a general optical disc drive;

FIG. 2 is a perspective view of an apparatus for automatically adjusting tilting of an optical disc drive according to an embodiment of the present invention;

FIG. 3 is a perspective view of the apparatus, shown in FIG. 2, in which an optical disc drive is mounted;

FIG. 4 is a cross-sectional view taken along line A-A′ of FIG. 3;

FIG. 5 is a cross-sectional view of an autocollimator according to an embodiment of the present invention;

FIG. 6 is an exploded perspective view of portion B shown in FIG. 3;

FIG. 7 is a view showing a first focused point and a second focused point displayed on a screen of a monitor before adjusting tilting;

FIG. 8 is a view showing a first focused point and a second focused point displayed on a screen of a monitor after adjusting tilting; and

FIGS. 9A and 9B are flowcharts for explaining a method of automatically adjusting tilting of an optical disc drive according to an embodiment of the present invention.

< Explanation of Reference numerals designating the Major Elements of the Drawings >

20 - Spindle motor	30 – Rail
40 - Optical pickup unit	50 – Turntable
60 - Basic hole	70 – Spring
80 – Setscrew	110 - Placing part
120 - Height measurer	121 – Probe
130 – Adjuster	131 - Adjusting driver
140 – Autocollimator	141 - Reflecting mirror

142 - Focusing surface
150 – Camera
160 – Monitor
170 – Controller
210 - Mirror disc
220 – First mirror plates
230 - Second mirror plates
f10 – First focused points
f20 – Second focused points
P1 - Fixing part
P2, P3, P4 - Adjusting parts
Tr - Radial tilting
Tt - Tangential tilting

[Detailed Description of the Invention]

[Object of the Invention]

[Technical Field of the Invention and Related Art prior to the Invention]

The present invention relates to an apparatus and method for automatically adjusting tilting of an optical disc drive, and more particularly, to an apparatus and method for automatically adjusting tilting of an optical disc drive using an autocollimator.

Optical disc drives generally write or read data on or from a recording surface of an optical disc with a concentric track using a beam emitted from an optical pickup unit that slides in a radial direction of the spinning optical disc.

FIG. 1 is a perspective view of a general optical disc drive. Referring to FIG. 1, a spindle motor 20 and a pair of rails 30 are installed on a main base 10. An optical pickup unit 40 is installed to be capable of sliding along the rails 30.

The spindle motor 20 spins an optical disc D and a turntable 50 on which the optical disc D is placed in combined with a shaft of the spindle motor 20. The optical pickup unit 40 writes or reads data on or from a recording surface of the optical disc D and slides along the rails 30 in a radial direction of the optical disc D.

In order to accurately read or write data on or from the recording surface of the optical disc D in a optical disc drive, the recording surface of the optical disc D have to be always at a predetermined angle with the optical axis of a beam emitted from the optical pickup unit 40. For this, the surface of the turntable 50 has to be parallel with the rails 30 that guide the sliding of the optical pickup unit 40.

In general, the surface of the turntable 50 fails to be parallel with the rails 30 due to an error in parts of the spindle motor 20 and the rails 30 and an error occurring when assembling the parts. Thus, the optical axis of the beam emitted from the optical

pickup unit 40 and the recording surface of the optical disc D deviate from a predetermined angle, which is called tilting. Tilting is classified into radial tilting **Tr** that refers to the slope in a direction where the optical pickup unit 40 slides along the surface of the optical disc D, i.e., in the radial direction of the optical disc D, and tangential tilting **Tt** that refers to the slope in a direction perpendicular to the radial direction.

A tilting adjusting method includes a method of adjusting the slope of the spindle motor 20 and a method of adjusting the slope of the rails 30. The method of adjusting the slope of the rails 30 is classified into a two-point adjusting method by which two points P3 and P4 around the outer circumference of the optical disc D ascend and a three-point adjusting method by which two points P3 and P4 and point P2 ascend. If the three-point adjusting method is used, P1 is a fixing part. Since the two-point adjusting method degrades the accuracy of adjusting tangential tilting, the three-point adjusting method is mainly used.

A process of adjusting tilting using the three-point adjusting method will be described. First, the parallel degree between the turntable 50 and the rails 30 is measured using optical equipment to calculate the amount of tilting. Next, a worker raises three adjusting parts P2, P3, and P4 according to the amount of tilting. Here, the worker repeats the raising work until the amount of tilting reaches a predetermined permitted limit.

When manufacturing optical disc drives, a process of adjusting tilting is generally performed. In a case where errors occur frequently when adjusting tilting, it takes a considerable amount of time to adjust tilting. Thus, the productivity of optical disc drives decreases. Also, a worker directly should raise an adjusting part to adjust tilting. Thus, when an unskilled worker adjusts tilting, the uniformity of adjusting tilting decreases and a significant amount of time is required for adjusting tilting.

[Technical Goal of the Invention]

The present invention provides an apparatus and method for automatically adjusting tilting of an optical disc drive by detecting the amount of tilting using an autocollimator and automatically adjusting tilting according to the amount of tilting.

[Structure and Operation of the Invention]

According to an aspect of the present invention, there is provided an apparatus for automatically adjusting tilting between an optical pickup unit sliding along a pair of rails supported by three adjusting parts and one fixing part and a turntable on which an optical disc drive is placed. The apparatus includes placing parts, a plurality of height measurers, adjusters, a mirror disc, two mirror plates, an autocollimator, a photo detector, and a controller. The optical disc drive is placed on the placing parts. The plurality of height measurers measure heights of two portions of each of the pair of rails. The adjusters raise the adjusting parts. The mirror disc is mounted on the turntable and spins. The two mirror plates are installed close to the turntable across the pair of rails. The autocollimator radiates parallel light beams onto the mirror disc and the two mirror plates. The photo detector detects focused points of the light beams reflected from the mirror disc and the two mirror plates and passing through the autocollimator. The controller calculates an amount of tilting from a distance between the focused points.

According to another aspect of the present invention, there is provided a method of automatically adjusting tilting of an optical disc drive by which tilting between an optical pickup unit sliding along a pair of rails supported by three adjusting parts and one fixing part and a turntable on which the optical disc drive is placed is adjusted. A pair of rails is adjusted to be parallel. Parallel light beams are radiated onto a mirror disc that is mounted on the turntable and spins and two mirror plates that are installed close to the turntable across the pair of rails using an autocollimator. An amount of tilting is calculated from focused points of two light beams reflected from the mirror disc and the mirror plates and passing through the autocollimator. The adjusting parts are raised according to the amount of tilting.

After raising the adjusting parts, the amount of tilting is re-calculated from the focused points of two light beams reflected from the mirror disc and the mirror plates and passing through the autocollimator to check whether the amount of tilting satisfies a predetermined permitted limit.

Since a process of adjusting tilting can be automatized, an efficiency of a process of manufacturing optical disc drives can be improved and cost for manufacturing the optical disc drives can be saved.

Preferred embodiments of the present invention will now be described with reference to the attached drawings.

FIG. 2 is a perspective view of an apparatus for automatically adjusting tilting of an optical disc drive according to an embodiment of the present invention, and FIG. 3 is a perspective view of the apparatus, shown in FIG. 2, in which an optical disc drive is mounted.

Referring to FIG. 2, placing parts 110, height measurers 120, adjusters 130, and an autocollimator 140 are installed on a base 100. A camera 150 is installed in the autocollimator 140 and connected to a controller 170 and a monitor 160.

An optical disc drive is placed on the placing parts 110 to adjust tilting. As shown in FIG. 3, since basic bosses 111, which protrude from the placing parts 110, are inserted into 4 basic holes 60 formed in a main base 10, the optical disc drive is placed on the placing parts 110. Heights **H1** of the placing parts 110 are the same.

The height measurers 120 include probes 121 that contact bottom portions of rails 31 and 32 and ascend according to the height of rails 31 and 32. In order to check whether the rails 31 and 32 are parallel, heights of at least two portions of each of the rails 31 and 32 should be measured. Thus, the height measurers 120 have to be at least four. Heights **H2** of the probes 120 are the same when the optical disc drive is not mounted. As shown in FIG. 4, the probes 121 are installed slightly higher than the height where the rails 31 and 32 are to be installed. It is preferable that the height measurers 120 are installed so that the probes 121 contact portions of the rails 31 and 32 close to a fixing part P1 and adjusting parts P2, P3, and P4 installed at ends of the rails 31 and 32. The amount of ascent of the probes 121 is transmitted to the controller 170 to check whether the rails 31 and 32 are parallel, and if the rails 31 and 32 are not parallel, to calculate the amount of ascent of the adjusting parts P2, P3, and P4.

The adjusters 130 raise the adjusting parts P2, P3, and P4 of the rails 31 and 32. Adjusting drivers 131, which are installed on ends of the adjusting parts 130, are screwed into setscrews 80 installed beneath the adjusting parts P2, P3, and P4 when the optical disc drive is placed on the placing parts 110. As shown in FIG. 4, springs 70, which are opposite to the setscrews 80, press the rails 31 and 32 toward the setscrews 80. Thus, since the setscrews 80 are screwed by turning the adjusting drivers 131, the rail 31 ascends and descends according to the amount of the screwing of the setscrews 80. The adjusting parts P2 and P4 are the same as described above. The controller 170 controls the adjusters 130.

The autocollimator 140 radiates a parallel light beam onto an object via an objective lens and focuses the beam reflected from the object onto a focusing surface. Here, the distance between a focused point and a focal point is proportional to the slope of the object. FIG. 5 illustrates optical paths along which light beams emitted from the autocollimator 140 are reflected from reflective surfaces 300 and 301, incident onto the autocollimator 140, reflected on a reflecting mirror 141, and focused onto a focusing surface 142. A light beam incident on the reflective surface 300, which is perpendicular to an incident light beam B1, is focused onto the focusing surface 142 through an optical path of B1-B2-B3. A light beam incident on the reflective surface 301, which is at an angle of α with the reflective surface 300, is focused onto the focusing surface 142 through an optical path of B1-B3-B4. Here, a distance **d1** between two focused points is proportional to the angle α between the reflective surfaces 300 and 301. If the reflective surfaces 300 and 301 are parallel, light beams are focused at the same point. Thus, **d1** becomes zero.

The camera 150 is a kind of photo detectors that detect a focused point formed on the autocollimator 140 and photographs the focusing surface 142 to detect a focused point. An image on the focusing surface 142 photographed by the camera 150 is displayed on the monitor 160.

In order to measure tilting of the turntable 50 and the rails 30 using the autocollimator 140, reflectors have to be installed on the turntable 50 and the rail 30.

FIG. 6 is an exploded perspective view of portion B shown in FIG. 3. Referring to FIG. 6, a mirror disc 210 is installed as a reflector on the turntable 50 and mirror plates (not shown) are installed as reflectors on the rail 30. The mirror disc 210 measures the slope of the turntable 50, is spun by the spindle motor 120, and reflects a light beam emitted from the autocollimator 140.

The mirror plates are placed on the rails 31 and 32 and need to be two to measure the slopes of the rails 31 and 32. In a case where two mirror plates are respectively installed toward inner and outer circumferences of the optical disc, an autocollimator having the effective area that is denoted by reference numeral 320 is used or autocollimators having the effective areas that are denoted by reference numerals 310 and 330 are used. However, in an event that two mirror plates are installed toward the inner circumference of the optical disc, only the autocollimator having the effective area that is denoted by reference numeral 310 is used. As shown

in FIG. 6, in the present embodiment, a first mirror plate 220 and a second mirror plate 230 are installed down and up at a predetermined distance. For this, the first plate 220 includes first supports 222 that are supported on two portions of the rail 31 and on one portion of the rail 32 and a first reflective surface 221 that reflects light. The second mirror plate 230 includes second supports 232 that are supported on one portion of the rail 31 and on two portions of the rail 32, a second reflective surface 232 that reflects light, and a connection hole 233 through which light is transmitted to the first reflective surface 221. Here, heights **H3** of the second supports 232 are determined in consideration of heights **H4** of the first supports 222 so that the first mirror plate 220 does not interferes with the second mirror plate 230.

FIGS. 7 and 8 respectively illustrate first and second focused points before and after adjusting tilting displayed on a screen of a monitor, and FIGS. 9A and 9B are flowcharts for explaining a method of automatically adjusting tilting of an optical disc drive according to an embodiment of the present invention.

A method of adjusting tilting will now be described with reference to FIGS. 1 through FIG. 9B.

In step A1, an optical disc drive is placed on the placing parts 110. Thereafter, as shown in FIG. 3 and 5, the mirror disc 210 is mounted on the turntable 50, and the first and second plates 220 and 230 are placed on the rail 30. Here, the first and second mirror plates 220 and 230 are installed down and up toward the inner circumference of the optical disc. Then, upper ends of the probes 121 contact the bottom portions of the rails 31 and 32. As previously described, the initial heights **H2** of the probes 121 are higher than the rails 31 and 32. Thus, as shown in FIG. 4, the heights **H2** of the probes 121 contacting the bottom portions of the rails 31 and 32 vary by reference character **h**. Information on the variation **h** is transmitted to the controller 170. Since two of the probes 121 contact each of the rails 31 and 32, in step A2, data on height changes of four probes are transmitted to the controller 170. In step A3, the controller 170 spins the adjusting drivers 131 installed on the adjusters 130, adjusts the amount of screwing of the setscrews 80, and allows the adjusting points P2, P3, and P4 to ascend. In step A, if the heights of four probes vary equally, the heights **H1** of the placing parts 110 are the same and the initial heights **H2** of the probes 121 are the same. Thus, the rails 31 and 32 are parallel.

Here, the mirror disc 210 and the first and second mirror plates 220 and 230 may be installed after the rails 31 and 32 are adjusted to be parallel. In this case, since the state of the mounted optical disc drive may vary, as described above, it is preferable that the mirror disc 210 and the first and second mirror plates 220 and 230 are preinstalled to maintain the uniformity of an adjusting work.

In step B, the autocollimator 140 radiates parallel light beams onto the mirror disc 210 and the first and second mirror plates 220 and 230. The mirror disc 210 may be spun when step A starts or after step A finishes.

The parallel light beams emitted from the autocollimator 140 and reflected from the mirror disc 210 and the first and second mirror plates 220 and 230 are focused on predetermined positions of the focusing surface 142 according to the amount of tilting of the turntable 50 and the rails 31 and 32. In FIG. 7, the focusing surface 142 is photographed by the camera 150 and displayed on the monitor 160. A focused point **f21** is formed by the mirror disc 210, and focused points **f11** and **f12** are formed by the first and second mirror plates 220 and 230. Since the rails 31 and 32 have been already adjusted to be parallel, the focused points **f11** and **f12** formed by the first and second mirror plates 220 and 232 almost overlap. If the rails 31 and 32 are not parallel, the focused points **f11** and **f12** may become distant from each other. If the rails 31 and 32 are accurately adjusted to be parallel, the focused points **f11** and **f12** may completely overlap, and thus one focused point may be seen. The focused point **f21** formed by the mirror disc 210 is almost circular. If the mirror disc 210 is completely flat, the focused point **f21** is focused as one point like the focused points **f11** and **f12**. However, the mirror disc 210 cannot be completely flat but wobbles slightly. Thus, if a light beam is radiated onto the mirror disc 210 that is spinning, a focused point is focused to be nearly circular like the focused point **f21** shown in FIG. 7. The focused point **f21** shown in FIG. 7 is not completely closed circle. However, the focused point **f21** may be completely closed circle depending on the spin speed of the mirror disc 210 and the shutter speed of the camera 150.

The controller 170 calculates coordinates of first and second focused points **f10** and **f20** and calculates the amount of tilting from the coordinates. The coordinates may be calculated from a focused point on a charge coupled device (CCD; not shown) built in the camera 150 or from a focused point on a screen of the monitor 160. In the

present embodiment, the coordinates are calculated from the focused point on the screen of the monitor 160.

As described above, since the rails 31 and 32 have been already adjusted to be parallel, the focused points **f11** and **f12** nearly overlap. The controller 170 recognizes a central point where the focused points **f11** and **f12** overlap as the first focused point **f10** and calculates coordinates of the first focused point **f10**. The focused point **f21** is almost circular as previously described. In step C1, the controller 170 places three points on the circumference of the focused point **f21**, recognizes a central point as the second focused point **f20**, and calculates coordinates of the second focused point **f20**.

In FIG. 6, if optical paths B1, B2 and B1+B2 are identified, the relationship between the slope angle α and the focusing distance **d1** can be identified. If the size of the CCD (not shown) built in the camera 150 is identified, the relationship between the distance between focused points on the CCD and the slope angle α can be identified. Moreover, if the size of the screen of the monitor 160 is identified, the relationship between a distance **d2** between focused points on the screen of the monitor 160 and the slope angle α can be identified. Thus, the slope angle α between the mirror disc 210 and the mirror plates 220 and 230 can be identified from the distance between the focused points on the CCD and the distance **d2** between the focused points on the screen of the monitor 160. The slope angle α is the amount of tilting between the turntable 50 and the rails 31 and 32. For example, describing the relationship between a slope angle of a reflective surface and the distance between the focused points on the screen of the monitor 160, the lengths of the optical paths B1, B2, and B1+B2, the size of the CCD, and the size of the screen of the monitor 160 are determined so that when the slope angle is 0.005, the distance between the focused points on the screen of the monitor 160 is 1mm. Then, as shown in FIG. 7, in step C2, a tangential tilting amount **Tt** and a radial tilting amount **Tr** become $Tt=0.005\times dt$ and $Tr=0.005\times dr$.

If the first focused point **f10** or the second focused point **f20** cannot be detected, in step C3, the controller 170 stops adjusting tilting and displays an error via the screen of the monitor 160 or a warning sound. If the mirror disc 210 and the first and second mirror plates 220 and 230 are not installed, this phenomenon may occur.

As described above, after in step C, the tangential tilting amount **Tt** and the radial tilting amount **Tr** are calculated, in step D, the amounts of ascent of the adjusting parts

P2, P3, and P4 are calculated from the tangential tilting amount **Tt** and the radial tilting amount **Tr,** and the amounts of screwing of the setscrews 80 are adjusted using the adjusters 130 so that the tangential tilting amount **Tt** and the radial tilting amount **Tr** are within a predetermined permitted limit.

In step D1, the amounts of ascent of the adjusting parts P2, P3, and P4 are calculated. For example, if a distance between the fixing part P1 and the adjusting part P3 of the rail 31 is assumed as **d3**, the amount of ascent of the adjusting part P3 for adjusting the radial tilting amount **Tr** is d3×SIN (0.005×dr). Also, a distance between the rails 31 and 32 is assumed as **d4**, the amount of ascent of the adjusting parts P2 and P4 for adjusting the tangential tilting amount **Tt** is d4×SIN(0.005×dt).

After calculating the amounts of ascent of the adjusting parts P2, P3, and P4, the adjusters 130 operate so that the adjusting parts P2, P3, and P4 ascend. The controller 170 calculates the amounts of screwing of the setscrews 80 necessary for raising the adjusting parts P2, P3, and P4 from the amounts of ascent of the adjusting parts P2, P3, and P4 and the pitch of the setscrews 80 and turns the adjusting drivers 131 screwed into the setscrews 80 by the screwing amounts of the setscrews 80. Here, the radial tilting amount **Tr** is adjusted, and then the tangential tilting amount **Tt** is adjusted. This order may be inversed. The adjusting parts P3 and P4 ascend to adjust the radial tilting amount **Tr**. Since the optical pickup unit 40 is supported on two portions of the rail 31 as shown in FIG. 1, although only the adjusting part P2 ascends, the radial tilting amount **Tr** is adjusted. However, in this case, the rails 31 and 32 are not parallel. Thus, the adjusting parts P3 and P4 have to ascend by the same amount. Then, in step D2, the rails 31 and 32 are kept to be parallel and the adjustment of tilting in the radial direction is completed. Thereafter, the adjusting parts P2 and P4 of the rail 32 ascend to adjust the tangential tilting amount Tt. Then, in step D3, the rails 31 and 32 are kept to be parallel and the adjustment of tilting in the tangential direction is completed. As described above, after the adjustment of tilting is completed, as shown in FIG. 8, a portion of the first focused point **f10** overlaps a portion of the second focused point **f20** on the screen of the monitor 160.

After performing step D, in step E, step C is performed one more time to check whether the amount of tilting is within a predetermined permitted limit. If the tilting amount is not within the predetermined permitted limit, step D may be performed again. If the tilting amount is still not within the predetermined permitted limit even when steps

C and D are performed as many times as the set maximum number of times tilting is adjusted, the tilting amount that is not within the predetermined permitted limit may be displayed via the screen of the monitor 160 or the warning sound, and then the adjustment of tilting may stop.

While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the following claims.

[Effect of the Invention]

As described above, using an apparatus and method for automatically adjusting tilting of an optical disc drive according to the present invention, the following effects can be achieved.

Since two mirror plates are installed up and down toward the inner circumference of an optical disc, cheap auto collimators having the effective area relatively smaller than when two mirror plates are installed toward the inner and outer circumferences of the optical disc can be used.

Also, unlike a conventional tilting adjusting method depending on skill of a worker, the amount of tilting can be automatically measured and tilting can be automatically adjusted. Thus, tilting can be uniformly and precisely adjusted.

Moreover, since a process of adjusting tilting can be automatized, an efficiency of a process of manufacturing optical disc drives can be improved and cost for manufacturing the optical disc drives can be saved.

What is claimed is:

1. An apparatus for automatically adjusting tilting between an optical pickup unit sliding along a pair of rails supported by three adjusting parts and one fixing part and a turntable on which an optical disc drive is placed, the apparatus comprising:

placing parts on which the optical disc drive is placed;

a plurality of height measurers that measure heights of two portions of each of the pair of rails;

adjusters that raise the adjusting parts;

a mirror disc that is mounted on the turntable and spins;

two mirror plates that are installed close to the turntable across the pair of rails;

an autocollimator that radiates parallel light beams onto the mirror disc and the two mirror plates;

a photo detector that detects focused points of the light beams reflected from the mirror disc and the two mirror plates and passing through the autocollimator; and

a controller that calculates an amount of tilting from a distance between the focused points.

2. The apparatus of claim 1, wherein the two mirror plates are spaced apart from each other up and down.

3. The apparatus of claim 2, wherein the two mirror plates are a first mirror plate that includes a first reflective surface and first supports supported on two portions of one of the pair of rails and on a portion of the other of the pair of rails and a second mirror plate that is installed over the first mirror plate and includes a second reflective surface, second supports symmetrical to the first mirror plate, and a connection hole through which the light beams are transmitted to the first reflective surface.

4. The apparatus of any one of claims 1 and 2, further comprising a monitor that displays the focused points detected by the photo detector.

5. The apparatus of any one of claims 1 and 2, wherein the height measurers are installed near to the fixing part and the adjusting parts.

6. A method of automatically adjusting tilting of an optical disc drive by which tilting between an optical pickup unit sliding along a pair of rails supported by three adjusting parts and one fixing part and a turntable on which the optical disc drive is placed is adjusted, the method comprising:

(a) adjusting a pair of rails to be parallel;

(b) radiating parallel light beams onto a mirror disc that is mounted on the turntable and spins and two mirror plates that are installed close to the turntable across the pair of rails using an autocollimator;

(c) calculating an amount of tilting from focused points of two light beams reflected from the mirror disc and the mirror plates and passing through the autocollimator; and

(d) raising the adjusting parts according to the amount of tilting.

7. The method of claim 6, wherein the two mirror plates are spaced apart from each other up and down.

8. The method of claim 7, wherein a first mirror plate that includes a reflective surface and supports supported on two portions of one of the pair of rails and on a portion of the other of the pair of rails and a second mirror plate that is installed over the first mirror plate and includes a reflective surface, second supports symmetrical to the first mirror plate, and a connection hole through which the light beams are transmitted to the first reflective surface.

9. The method of claim 7, further comprising step (e) of performing step (c) again after step (d) to check whether the amount of tilting satisfies a predetermined permitted limit.

10. The method of claim 9, wherein if the amount of tilting does not satisfy the predetermined permitted limit, step (d) is performed again.

11. The method of claim 10, wherein if the number of times steps (c) and (d) are performed exceeds a predetermined maximum number of times tilting is adjusted, adjusting tilting stops.

12. The method of claim 7, wherein step (a) comprises:

(a1) placing the optical disc drive on the placing parts;

(a2) measuring heights of at least two portions of each of the pair of rails; and

(a3) raising the three adjusting parts so that heights of the pair of rails are the same.

13. The method of claim 12, wherein the height measurers are installed close to the fixing part and the adjusting parts.

14. The method of claim 7, wherein step (c) comprises:

(c1) detecting a first focused point formed by the two mirror plates in a predetermined moment and a second focused point formed by the mirror disc; and

(c2) calculating the amount of tilting from a distance between the first focused point and the second focused point.

15. The method of claim 14, wherein step (c) further comprises step (c3) of stopping adjusting tilting if the first and second focused points are not detected.

16. The method of claim 14, wherein the first and second focused points are displayed on a screen of a monitor.

17. The method of claim 14, wherein the first focused point is a central point on a line connecting two focused points formed by the first and second mirror plates.

18. The method of claim 14, wherein the second focused point is a central point of a circle formed by the mirror disc.

19. The method of claim 7, wherein step (d) comprises:

(d1) calculating amounts of ascent of the adjusting parts from the amount of tilting;

(d2) raising two of the adjusting parts in a radial direction of each of the pair of rails to adjust tilting in the radial direction; and

(d3) raising two adjusting parts of one of the pair of rails supported by the two adjusting parts to adjust tilting in a tangential direction.